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National Eutrophication Survey, Corvallis, Oreg

Prepared for

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NATIONAL EUTROPHICATION SURVEY

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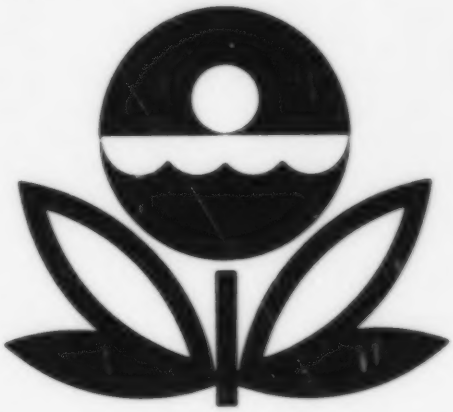

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

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REPORT
ON
SPIRITWOOD LAKE
STUTSMAN COUNTY
NORTH DAKOTA
EPA REGION VIII
WORKING PAPER No. 576

WITH THE COOPERATION OF THE
NORTH DAKOTA STATE DEPARTMENT OF HEALTH
AND THE
NORTH DAKOTA NATIONAL GUARD
OCTOBER, 1976

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the North Dakota State Department of Health for professional involvement, to the North Dakota National Guard for conducting the tributary sampling phase of the Survey, and to those North Dakota wastewater treatment plant operators who voluntarily provided effluent samples and flow data.

Norman L. Peterson, Director, and the staff of the Division of Water Supply and Pollution Control of the Department of Health, provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

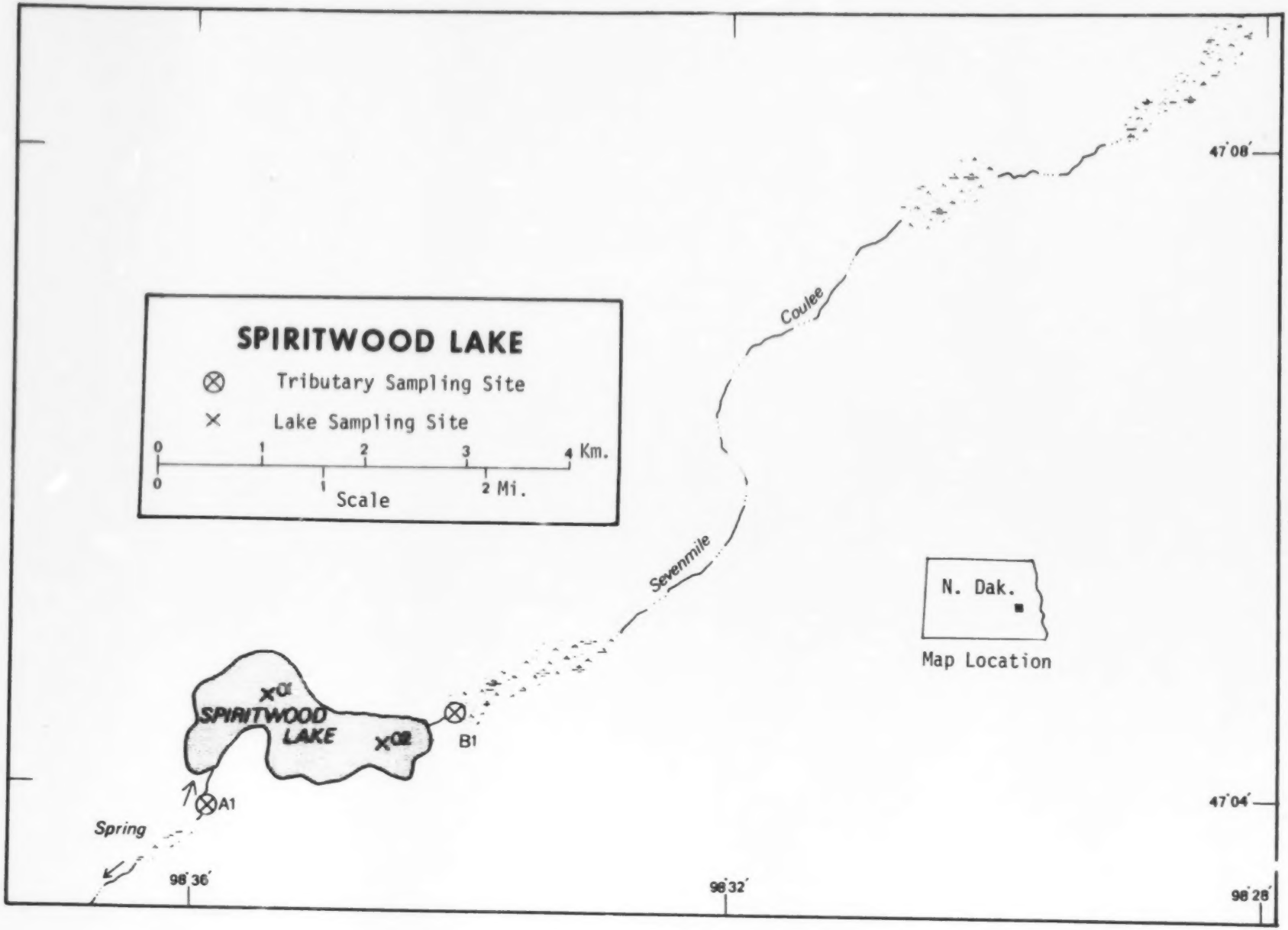
Major General LaClair A. Melhouse, the Adjutant General of North Dakota, and Project Officer Colonel Irvin M. Sande, who directed the volunteer efforts of the North Dakota National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES AND RESERVOIRS

STATE OF NORTH DAKOTA

NAME	COUNTY
Ashtabula	Barnes, Griggs
Audubon	McLean
Brush	McLean
Darling	Renville, Ward
Devils	Benson, Ramsey
Jamestown	Stutsman
LaMoure	LaMoure
Matejcek	Walsh
Metigoshe	Bottineau
Pelican	Bottineau
Sakakawea	Dunn, McKenzie, McLean, Mercer, Mountrail, Williams
Spiritwood	Stutsman
Sweet Briar	Morton
Whitman	Nelson, Walsh


SPIRITWOOD LAKE
Tributary Sampling Site
Lake Sampling Site
0 1 2 3 4 Km.
0 1 2 Mi.
Scale
Coulee
Sevenmile
Spring
SPIRITWOOD LAKE
A1
B1
N. Dak.
Map Location
47°08'
47°04'
98°36'
98°32'
98°28'

SPIRITWOOD LAKE

STORET NO. 3813

I. INTRODUCTION

Spiritwood Lake was included in the National Eutrophication Survey as a water body of interest to the North Dakota Department of Health. Because of little or no flow, only one tributary sample (station A-1) was collected; therefore, this report relates only to the lake sampling data. However, the tributary sampling data are included in Appendix D for the record.

Spiritwood Lake is a typical prairie lake. The primary uses of the lake include recreation and fishing. A major source of water to the lake is a watershed to the northeast and one to the northwest of the lake. The lake has no outlet except for overflow discharge into Seven Mile Coulee. Nutrients reaching the lake are from agricultural activities in the drainage and from lakeshore dwellings (Peterson, 1974).

II. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Spiritwood Lake is eutrophic. It ranked eighth in overall trophic quality when the 14 North Dakota lakes sampled in 1974 were compared using a combination of six water quality parameters*. Seven of the lakes had less median total and dissolved phosphorus, ten had less median inorganic nitrogen, nine had less mean chlorophyll a, and three had greater mean

* See Appendix A.

Secchi disc transparency. Depletion of dissolved oxygen occurred with depth at both stations in July.

Survey limnologists noted a heavy algal bloom in July and shoreline macrophytes in July and September. Severe impairment of use of the lake due to heavy algal blooms and excessive weed growths has been reported (Peterson, 1975).

B. Rate-Limiting Nutrient:

The algal assay results indicate that Spiritwood Lake was limited by nitrogen at the time the samples were collected (04/26/74 and 09/17/74). The lake data indicate nitrogen limitation at all sampling stations and times.

III. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Lake Morphometry††:

1. Surface area: 1.67 kilometers^2.
2. Mean depth: 8.8 meters.
3. Maximum depth: 16.2 meters.
4. Volume: 14.696 x 10^6 m^3.
5. Mean hydraulic retention time: Unknown.

B. Precipitation*:

1. Year of sampling: 60.7 centimeters.
2. Mean annual: 47.7 centimeters.

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† Table of metric conversions--Appendix B.
†† Henegar, 1975.
* See Working Paper No. 175, "...Survey Methods, 1973-1976".

IV. LAKE WATER QUALITY SUMMARY

Spiritwood Lake was sampled three times during the open-water season of 1974 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a number of depths at two stations on the lake (see map, page v). During each visit, a single depth-integrated (4.6 m to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the April and September visits, an 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 12.2 meters at station 1 and 10.7 meters at station 2.

The sampling results are presented in full in Appendix C and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR SPIRIT WOOD LAKE
STORET CODE 3813

PARAMETER	1ST SAMPLING (4/26/74) 2 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (7/17/74) 2 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (9/17/74) 2 SITES RANGE	MEAN	MEDIAN
TEMP (C)	3.1 - 5.8	4.4	3.8	11.2 - 24.9	20.5	24.1	14.8 - 15.7	15.1	15.0
DISS OXY (MG/L)	5.4 - 10.6	8.0	7.6	0.0 - 11.4	6.6	9.7	8.0 - 9.6	8.9	9.1
CNDCTVY (MCROMO)	1716. - 1766.	1737.	1736.	2130. - 2898.	2635.	2837.	2313. - 2369.	2333.	2329.
PH (STAND UNITS)	8.5 - 8.6	8.6	8.6	8.6 - 9.0	8.8	8.9	8.9 - 8.9	8.9	8.9
TOT ALK (MG/L)	322. - 376.	347.	339.	255. - 402.	346.	345.	500. - 730.	624.	618.
TOT P (MG/L)	0.171 - 0.208	0.183	0.181	0.133 - 0.414	0.210	0.174	0.103 - 0.141	0.116	0.110
ORTHO P (MG/L)	0.077 - 0.153	0.115	0.125	0.059 - 0.356	0.149	0.101	0.039 - 0.056	0.046	0.046
NO2+NO3 (MG/L)	0.180 - 0.220	0.191	0.185	0.030 - 0.140	0.076	0.055	0.020 - 0.030	0.024	0.020
AMMONIA (MG/L)	0.360 - 0.680	0.515	0.560	0.040 - 1.020	0.312	0.130	0.200 - 0.280	0.246	0.250
KJEL N (MG/L)	2.200 - 2.700	2.450	2.500	2.200 - 3.000	2.510	2.400	2.100 - 2.700	2.490	2.500
INORG N (MG/L)	0.580 - 0.860	0.706	0.750	0.070 - 1.130	0.388	0.185	0.220 - 0.300	0.270	0.270
TOTAL N (MG/L)	2.380 - 2.880	2.641	2.695	2.230 - 3.110	2.586	2.485	2.120 - 2.730	2.514	2.525
CHLRPYL A (UG/L)	2.5 - 12.4	7.4	7.4	77.4 - 84.3	80.8	80.8	15.6 - 15.8	15.7	15.7
SECCHI (METERS)	2.7 - 3.7	3.2	3.2	0.9 - 1.2	1.1	1.1	2.0 - 2.0	2.0	2.0

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
04/26/74	1. Chlamydomonas sp.	3,738
	2. Melosira sp.	1,869
	3. Chroomonas sp.	353
	4. Dactylococcopsis sp.	176
	5. Flagellates	176
	Other genera	670
	Total	6,982
07/17/74	1. Aphanizomenon sp.	10,245
	2. Microcystis sp.	162
	3. Lyngbya sp.	40
	Total	10,447
09/17/74	1. Chroomonas sp.	376
	2. Stephanodiscus sp.	226
	3. Cryptomonas sp.	150
	4. Aphanizomenon sp.	113
	5. Microcystis sp.	75
	Total	940

2. Chlorophyll a -

Sampling Date	Station Number	Chlorophyll a (µg/l)
04/26/74	1	12.4
	2	2.5
07/17/74	1	77.4
	2	84.3
09/17/74	1	15.8
	2	15.6

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

a. April sample -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.095	0.598	15.9
0.050 P	0.145	0.598	15.4
0.050 P + 1.0 N	0.145	1.598	36.3
1.0 N	0.095	1.598	31.4

b. September sample -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.055	0.292	9.8
0.050 P	0.105	0.292	9.6
0.050 P + 1.0 N	0.105	1.292	32.2
1.0 N	0.055	1.292	23.5

2. Discussion -

The control yields of the assay alga, Selenastrum capricornutum, indicate that the potential primary productivity of Spiritwood Lake was high at the times the samples were taken (04/26/74 and 09/17/74). Also, the lack of growth response in both samples with the addition of phosphorus until nitrogen was also added indicates that the lake was limited by nitrogen at those times. Note that in both samples, the addition of nitrogen alone resulted in a yield significantly greater than that of the control.

The lake data indicate nitrogen limitation as well. The mean inorganic nitrogen/orthophosphorus ratios were 7/1 or less at both stations and all sampling times, and nitrogen limitation would be expected.

V. LITERATURE REVIEWED

Henegar, Dale, 1975. Personal communication (lake morphometry). ND Game & Fish Dept., Bismarck.

Peterson, Norman L., 1974. Personal communication (information on Spiritwood Lake). ND Dept. of Health, Bismarck.

_____, 1975. Personal communication (North Dakota State lake classification). ND Dept. of Health, Bismarck.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

10<

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
3801	LAKE ASHTABULA	0.260	0.160	472.250	40.892	10.600	0.170
3802	LAKE AUDUBON	0.067	0.220	446.222	11.322	11.000	0.015
3803	BRUSH LAKE	0.066	0.095	449.143	29.114	9.000	0.010
3804	LAKE DARLING	0.274	0.250	466.750	60.075	11.600	0.180
3805	DEVILS LAKE	0.630	0.140	449.333	38.508	14.600	0.469
3806	JAMESTOWN RESERVOIR	0.144	0.365	438.667	19.400	8.800	0.078
3807	LAKE LA MOURE	0.438	0.380	421.400	19.720	15.000	0.290
3808	MATEJCEK LAKE	0.228	0.440	475.167	2.683	14.400	0.179
3809	LAKE METIGOSHE	0.032	0.080	389.167	10.367	9.000	0.010
3811	PELICAN LAKE	0.034	0.070	364.500	10.950	12.800	0.006
3812	LAKE SAKAKAWEA (GARRISON	0.016	0.150	408.733	6.883	10.800	0.007
3813	SPIRIT WOOD LAKE	0.156	0.290	417.833	34.667	15.000	0.082
3814	SWEET BRIAR RESERVOIR	0.092	0.090	440.800	39.000	8.800	0.031
3815	WHITMAN LAKE	0.260	0.260	478.333	27.067	9.200	0.185

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NO
3801	LAKE ASHTABULA	27 (3)	54 (7)	15 (2)	8 (1)	62 (8)	38 (5)	204
3802	LAKE AUDUBON	69 (9)	46 (6)	46 (6)	69 (9)	46 (6)	69 (9)	345
3803	BRUSH LAKE	77 (10)	77 (10)	38 (5)	38 (5)	81 (10)	81 (10)	392
3804	LAKE DARLING	15 (2)	38 (5)	23 (3)	0 (0)	38 (5)	23 (3)	137
3805	DEVILS LAKE	0 (0)	69 (9)	31 (4)	23 (3)	15 (2)	0 (0)	138
3806	JAMESTOWN RESERVOIR	54 (7)	15 (2)	62 (8)	62 (8)	96 (12)	54 (7)	343
3807	LAKE LA MOURE	8 (1)	8 (1)	69 (9)	54 (7)	4 (0)	8 (1)	151
3808	MATEJCEK LAKE	38 (5)	0 (0)	8 (1)	100 (13)	23 (3)	31 (4)	200
3809	LAKE METIGOSHE	92 (12)	92 (12)	92 (12)	85 (11)	81 (10)	81 (10)	523
3811	PELICAN LAKE	85 (11)	100 (13)	100 (13)	77 (10)	31 (4)	100 (13)	493
3812	LAKE SAKAKAWEA (GARRISON	100 (13)	62 (8)	85 (11)	92 (12)	54 (7)	92 (12)	485
3813	SPIRIT WOOD LAKE	46 (6)	23 (3)	77 (10)	31 (4)	4 (0)	46 (6)	227
3814	SWEET BRIAR RESERVOIR	62 (8)	85 (11)	54 (7)	15 (2)	96 (12)	62 (8)	374
3815	WHITMAN LAKE	27 (3)	31 (4)	0 (0)	46 (6)	69 (9)	15 (2)	188

LAKES RANKED BY INDEX NOS.

12<

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	3809	LAKE METIGOSHE	523
2	3811	PELICAN LAKE	493
3	3812	LAKE SAKAKAWEA (GARRISON	485
4	3803	BRUSH LAKE	392
5	3814	SWEET BRIAR RESERVOIR	374
6	3802	LAKE AUDUBON	345
7	3806	JAMESTOWN RESERVOIR	343
8	3813	SPIRIT WOOD LAKE	227
9	3801	LAKE ASHTABULA	204
10	3808	MATEJCEK LAKE	200
11	3815	WHITMAN LAKE	188
12	3807	LAKE LA MOURE	151
13	3805	DEVILS LAKE	138
14	3804	LAKE DARLING	137

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR NORTH DAKOTA 03/16/76

LAKE CODE 3813 SPIRITWOOD LAKE

16<

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 42.0

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
3813A2	42.0	0.0	0.0	0.028	0.113	0.057	0.023	0.011	0.003	0.0	0.0	0.0	0.0	0.020
381381	28.7	0.0	0.0	0.028	0.113	0.057	0.025	0.017	0.006	0.003	0.003	0.003	0.003	0.021
381322	13.2	0.0	0.0	0.008	0.028	0.017	0.008	0.006	0.003	0.0	0.0	0.0	0.0	0.006

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 42.0
SUM OF SUB-DRAINAGE AREAS = 42.0
TOTAL FLOW IN = 0.33
TOTAL FLOW OUT = 0.24

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
3813A2	9	74	0.0	21	0.0				
	10	74	0.0	20	0.0				
	11	74	0.0	16	0.0				
	12	74	0.0	22	0.0				
	1	75	0.0	18	0.0				
	2	75	0.0	22	0.0				
	3	75	0.0	22	0.0				
	4	75	0.0	5	0.0				
	5	75	0.0	3	0.0	18	0.0		
	6	75	0.0	22	0.0				
	7	75	0.0	19	0.0				
	8	75	0.0	22	0.0				
381381	9	74	0.0	21	0.0				
	10	74	0.0	20	0.0				
	11	74	0.0	16	0.0				
	12	74	0.0	22	0.0				
	1	75	0.0	18	0.0				
	2	75	0.0	22	0.0				
	3	75	0.0	22	0.0				
	4	75	0.176	5	0.0	20	0.566		
	5	75	0.001	3	0.0				
	6	75	0.133	22	0.0				
	7	75	0.150	19	0.099				
	8	75	0.034	22	0.023				
381322	9	74	0.0						
	10	74	0.0						
	11	74	0.0						
	12	74	0.0						
	1	75	0.0						
	2	75	0.0						
	3	75	0.0						
	4	75	0.051						
	5	75	0.0						
	6	75	0.040						
	7	75	0.045						
	8	75	0.011						

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/03/16

381301
47 04 35.0 098 35 42.0 3
SPIRIT WOOD LAKE
38093 NORTH DAKOTA

18<

11EPALES 2111202
0040 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/04/26	14 50	0000	5.8		108	1725	8.60	332	0.360	2.200	0.220	0.077
	14 50	0005	5.8	10.2		1723	8.60	328	0.400	2.200	0.180	0.087
	14 50	0020	5.6	10.6		1716	8.60	322	0.400	2.300	0.180	0.089
	14 50	0037	3.7	8.2		1723	8.55	376	0.540	2.500	0.200	0.121
74/07/17	13 20	0000	24.6	10.6	48	2861	8.90	335	0.050	2.300	0.050	0.062
	13 20	0005	24.6	10.2		2850	9.00	375	0.040	2.200	0.030	0.091
	13 20	0015	23.9	9.2		2824	8.90	255	0.060	2.300	0.050	0.094
	13 20	0025	16.9	2.2		2382	8.70	355	0.330	2.200	0.140	0.173
	13 20	0037	11.2	0.0		2130	8.60	325	1.000	3.000	0.110	0.356
74/09/17	11 05	0000	15.4	9.4	78	2343	8.87	500	0.220	2.700	0.030	0.039
	11 05	0010	15.3	9.6		2341	8.89	730	0.240	2.400	0.020	0.042
	11 05	0015	15.1	9.2		2333	8.89	600	0.250	2.500	0.020	0.046
	11 05	0020	14.9	9.0		2325	8.89	575	0.240	2.400	0.030	0.047
	11 05	0030	14.9	8.8		2319	8.89	650	0.250	2.500	0.030	0.051
	11 05	0040	14.8	8.2		2313	8.89	700	0.270	2.600	0.030	0.056

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCOT LT REMNING PERCENT
74/04/26	14 50	0000	0.184	12.4	
	14 50	0005	0.175		
	14 50	0020	0.171		
	14 50	0037	0.185		
74/07/17	13 20	0000	0.191	77.4	
	13 20	0005	0.137		
	13 20	0009			1.0
	13 20	0015	0.157		
	13 20	0025	0.217		
	13 20	0037	0.414		
74/09/17	11 05	0000	0.107	15.8	
	11 05	0010	0.103		
	11 05	0015	0.112		
	11 05	0020	0.107		
	11 05	0030	0.117		
	11 05	0040	0.130		

ET RETRIEVAL DATE 76/03/16

381302
47 04 23.0 098 34 40.0 3
SPIRIT WOOD LAKE
46057 NORTH DAKOTA

19<

11EPALES 2111202
0037 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/04/26	15 15	0000	3.8		144	1748	8.60	346	0.580	2.600	0.200	0.131
	15 15	0005	3.8	7.0		1746	8.55	324	0.580	2.500	0.190	0.129
	15 15	0025	3.7	6.4		1746	8.55	374	0.580	2.600	0.180	0.130
	15 15	0032	3.1	5.4		1766	8.50	376	0.680	2.700	0.180	0.153
74/07/17	13 50	0000	24.9	11.0	37	2877	9.00	320	0.050	2.800	0.040	0.059
	13 50	0005	24.8	11.4		2877	9.00	390	0.040	2.500	0.050	0.068
	13 50	0015	24.4	10.2		2898	8.90	400	0.200	2.500	0.060	0.109
	13 50	0025	18.0	1.6		2508	8.80	300	0.330	2.300	0.120	0.159
	13 50	0035	11.5	0.0		2138	8.60	402	1.020	3.000	0.110	0.318
74/09/17	11 40	0000	15.7	9.6	78	2369	8.89	665	0.200	2.600	0.020	0.039
	11 40	0005	15.2	9.2		2339	8.89	595	0.250	2.100	0.020K	0.044
	11 40	0015	14.9	8.2		2325	8.89	590	0.260	2.500	0.020	0.046
	11 40	0025	14.8	8.0		2319	8.89	635	0.280	2.600	0.020	0.050

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/26	15 15	0000	0.177	2.5	
	15 15	0005	0.182		
	15 15	0025	0.180		
	15 15	0032	0.208		
74/07/17	13 50	0000	0.140	84.3	
	13 50	0005	0.133		
	13 50	0006			1.0
	13 50	0015	0.155		
	13 50	0025	0.203		
	13 50	0035	0.355		
74/09/17	11 40	0000	0.109	15.6	
	11 40	0005	0.104		
	11 40	0015	0.129		
	11 40	0025	0.141		

K VALUE KNOWN TO BE
LESS THAN INDICATED

APPENDIX E

TRIBUTARY DATA